VXS, A High Speed Cu Switch Fabric Interconnect for VME

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Abstract

VXS provides the VME architecture with an infusion of new technology and a roadmap for evolution while remaining backwards compatible. These seemingly opposing goals were achieved by careful planning and judicious selection of technologies. The platform level enhancements over the existing VME platform include improvements in mechanical packaging, 10 Gbs switch fabric interconnect technology, system management features, alignment and keying strategy, 2X power improvements, and cooling strategies. This work was done within the context of the VSO industry standards body to promote an eco-system of developers, vendors, and users.

The focus of this paper is the 10 Gbs switch fabric interconnect technology. In the maximum configuration defined by the VXS standard, the interconnect technology allows up to eighteen payload and two switch boards to be topologically connected with redundant 4x LVDS (Low Voltage Differential Signaling) links in a dual star configuration that fits within a 19" rackmount chassis. The connector technology, MultiGig RT2, is based on a non-traditional PCB chicklets mounted on the plug-in daughter card that has carefully controlled impedance and optimized footprints. The backplane connector uses traditional beam contacts. Density and robustness of the connector exceed most conventional pin and socket interconnects.

Electrical testing was carried out as part of the standards work to measure the performance of the interconnect. Testing was performed on both the stand-alone connector, as well as an all-inclusive system utilizing the RT2 connectors. Data was captured in the frequency domain (insertion loss) and time domain (impedance, connector noise, eye patterns). Eye pattern system data was collected at 3.125 Gbps and 10.0 Gbps data rates. Connector-only testing uses 0.063"

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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

boards on either side of the connector with optimized footprints and board parasitics to minimize board effects. The system configuration is constructed of 16" or 24" traces on 0.200" thick backplanes with 4" traces on 0.125" thick daughtercards on either end. Trace widths are 6 mils, and layer connections vary.

All boards are built with a common FR4 material. The results reported minimal insertion loss across the RT2 connector (-2 dB at 5.5 GHz), with acceptable eye openings of 32 % and 50 % for different system configurations at 3.125 Gbps. The combined use of the RT2 connector and advanced silicon techniques additionally demonstrated acceptable and exciting performance results at 10 Gbps.

The historical problems with card edge connectors in military and unattended applications made addressing these concerns a high priority for selection of a VXS connector that would be acceptable by the military and telecom companies. To address the COTS/Military concerns, it was decided that COTS/Military testing should be carried out on the MultiGig RT-3 connector to (1) determine if problems arise when the connector is subjected to the usual COTS/Military environmental tests for electronics, and (2) if the tests reveal no problems, give users of VME equipment in the COTS/Military markets a level of confidence that VXS will perform as expected. One additional concern of the VXS standards development task group was the effects of vibration on connectors carrying very high data rates. Very little test data could be found the effects of vibration on contact impedance and nano-second discontinuities.

Telecordia GR12-17 and Tyco Design Objectives 1082072 test requirements, were compared to MIL-STD-1344A, and were non-existent or less stringent, M1344A testing was performed. Salt Fog, Thermal Shock, Humidity (condensing) per M1344A, and Discontinuity per Test method EIA-367-87 [6] for "Nanosecond-Event Detection for Electrical Connectors, Contacts and Sockets. Pass-fail criteria shall be a changes in impedance of 10 Ohms or greater at a minimum event duration of 10.0 ns. From EIA-367-87, this is Test Condition D, Method 2.

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VME Renaissance

- VME is a +20 year old technology.
- VME Renaissance is an intense period of intellectual activity and technology infusion surrounding VMEbus
- Many innovations, including but not limited to
  - **Faster 2eSST parallel bus**
  - **Multi-gigabit switched serial interconnects**
  - **PCI-X chip to chip interconnect**
  - **PCI-X mezzanines**
  - **Point to point intra-connects**
  - **Point-to-point mezzanines**

VMEbus Technology Roadmap

Data Plane Inter-Connect

Parallel Switched
- Raceway™
- SKYchannel

Serial Switched
- Ethernet, Fibre Ch
- Infiniband™
- Serial RapidIO™
- 3GIO, etc. etc. etc.

Next Gen Fabric
- HA fabric
- Mesh
- Optical

Control Plane Inter-Connect

VME64 VMEbus

2eSST/P VM

2eSST/P2P VMEbus
- 2eSST VME side
- P-P Host side connect

Next Gen VMEbus
- QDR Technology

Mezzanine Inter-Connect

Point-to-Point Mezzanine
- P/S RapidIO™
- 3GIO
- Hypertransport
- Infiniband™, etc. etc.

Next Gen Mezzanine
- Hot plug
- Front Access

Chip to Chip Inter-Connect

Point-to-Point Chip Connect
- P/S RapidIO™
- 3GIO
- Hypertransport
- etc. etc.

Form Factor

- 160 millimeters deep

- VITA 34 or other Mo
- More power
- More cooling
- High availability supp
- Integrated chassis management

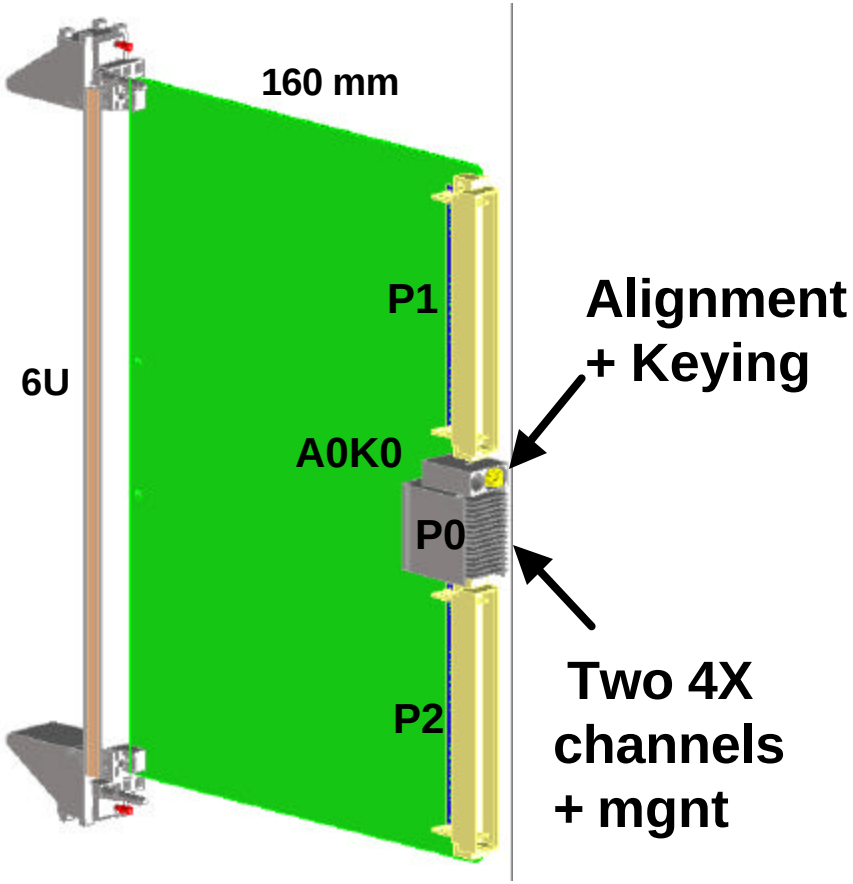
Next Gen Form

- VXS – VMEbus Switched Serial
- Adds multi-gigabit per second switched serial links to VME
- Via a new P0 connector
- Dual star configuration uses one or two switch cards
- Multiple link technologies supported by structured specification
- Additional power brought onto each card
- Plug Fest during 03' and 04'

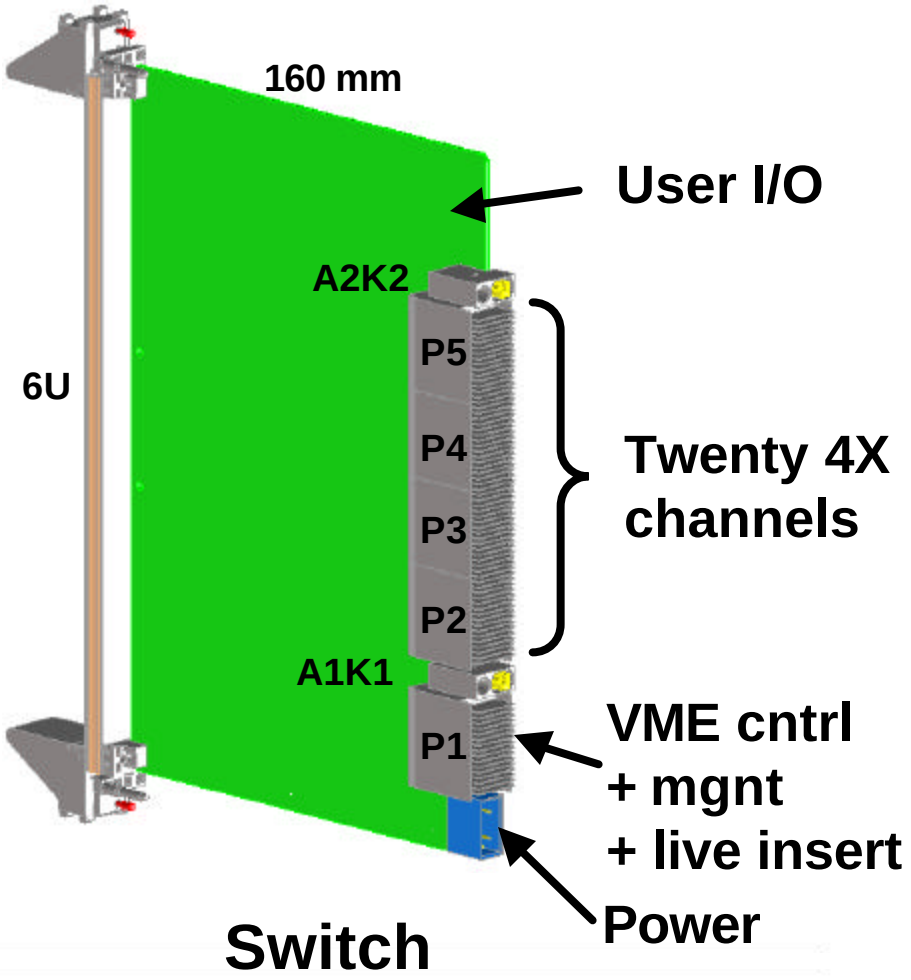
2001 **2002** **2003** **2004** **2005-10**

Source: Jeff Harris, Motorola

Payload and Switch Boards



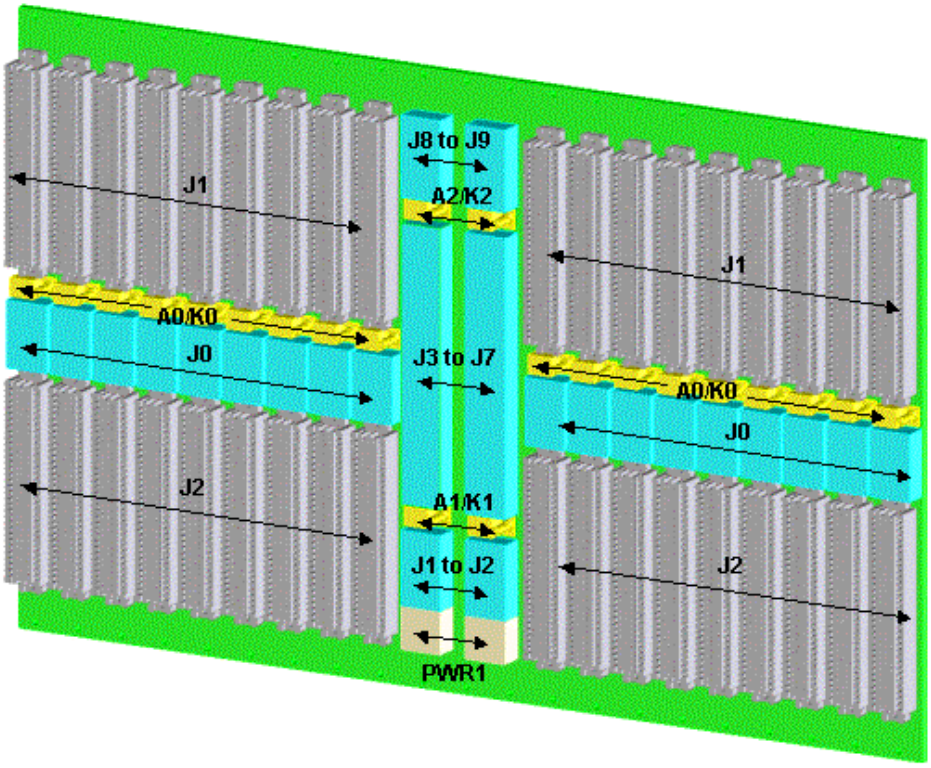
Payload



Switch

Interconnect Topologies

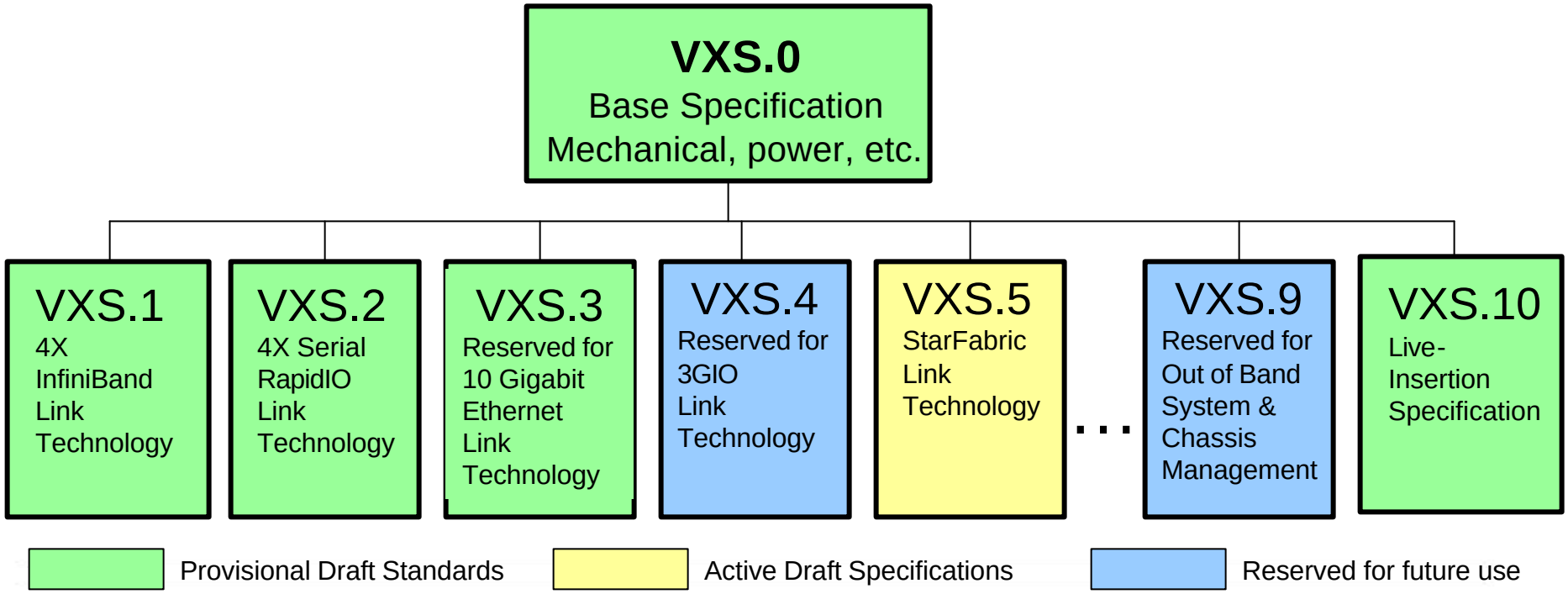
- VXS is topology agnostic
- Only Payload and Switch Board Pin outs defined
- Dual star
- Mesh
- Ring



Example Backplane
20 slot dual star

VSO (VITA Standards Organization)

- All work done under VSO (March 2002 to present)
- SIG (6 companies) -> Working Group (+20 companies)



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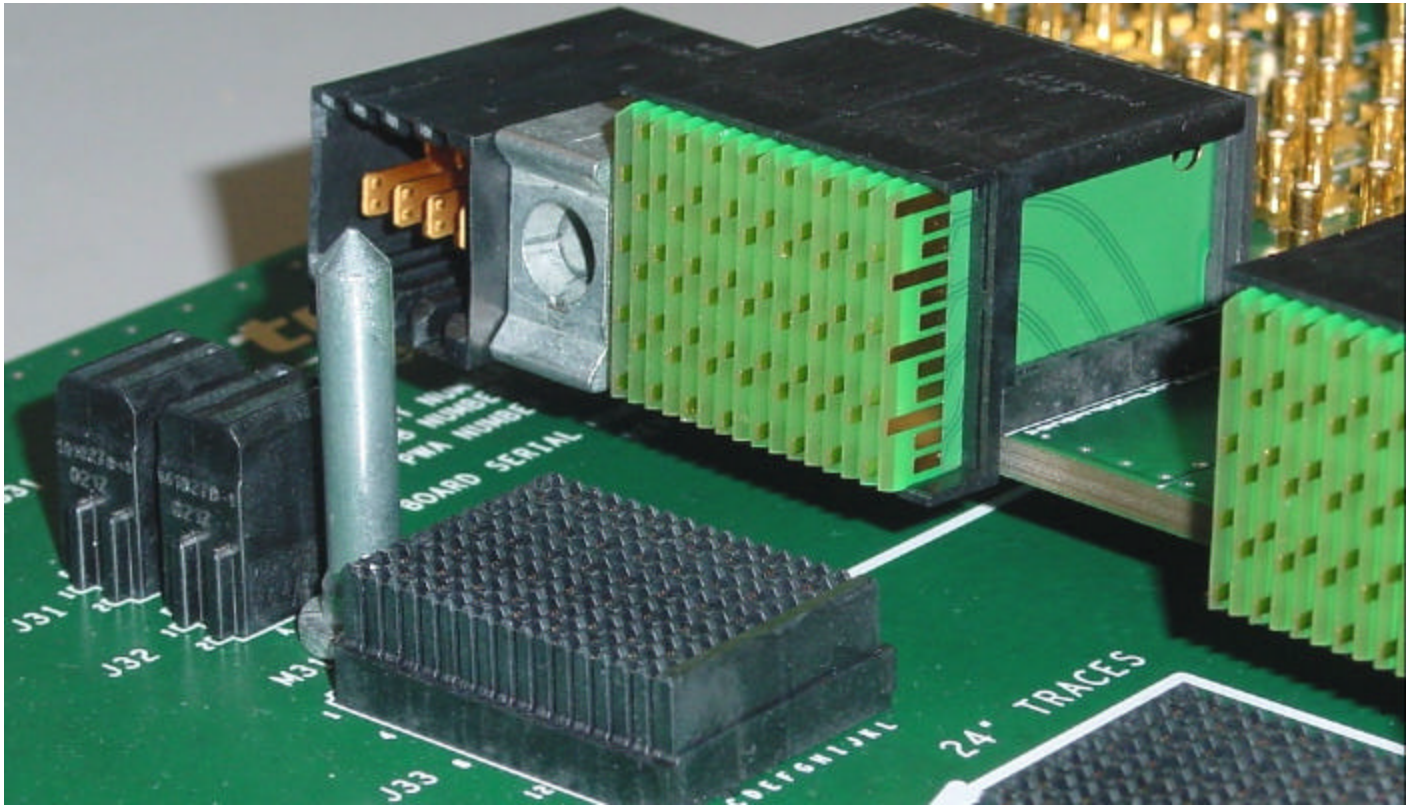
MultiGig RT-2 Assembly



Most Flexible, Most Dense, and Quiet
A Solution Revolution for Multi-Gigabit Backplane applications

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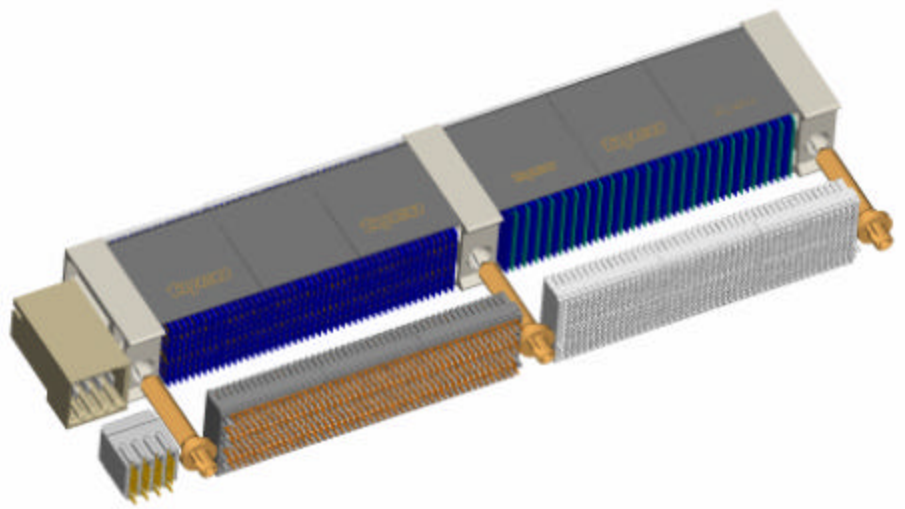
MultiGig Product Family Overview

Options

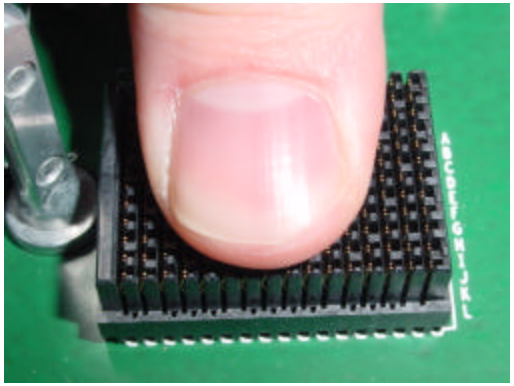
- Complete integrated solution
- Designed to fit within same envelope as signal modules



Power Connectors	18 A contacts, 2 & 4 lines/module
Guide Modules	8 keys/pin, Positive ESD Contact option
DC Organizer	Modules can be organized as monoblocks
Cross Connect	Orthogonal Design in Dev.

MultiGig Product Family Overview

Features and Benefits



>Mechanically Robust

- Pinless Backplane Solution
- Bellcore Compliant
- 250 cycle durability

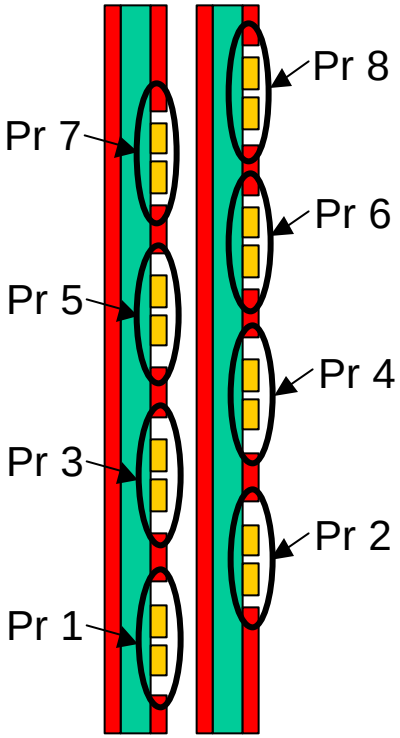
>Electrically Flexible

- Single Ended and Differential lines within a module
- PWB's for Power options available
- Length Matching
- Skew Control
- Options available down to 3% Noise at 50 ps

MultiGig RT-2 Differential - Near End Noise

Synchronous Noise
Multiple aggressors

Pair 7	2.9%	Pair 8	1.7%
Pair 5	3.0%	Pair 6	3.1%
Pair 3	2.9%	Pair 4	2.9%
Pair 1	2.7%	Pair 2	2.8%

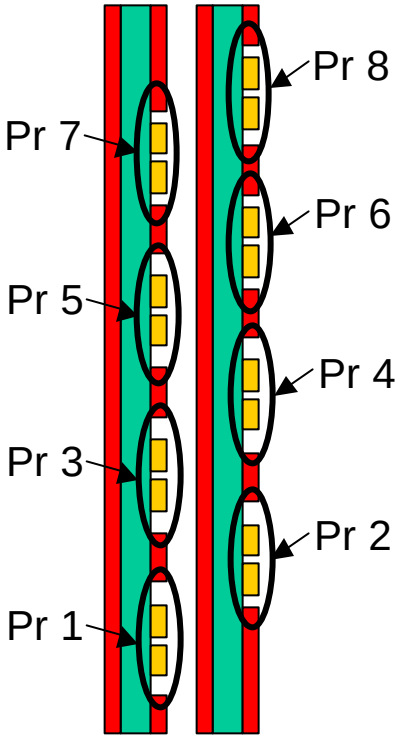


Edge rate: 47 ps (20-80%)

MultiGig RT-2 Differential - Far End Noise

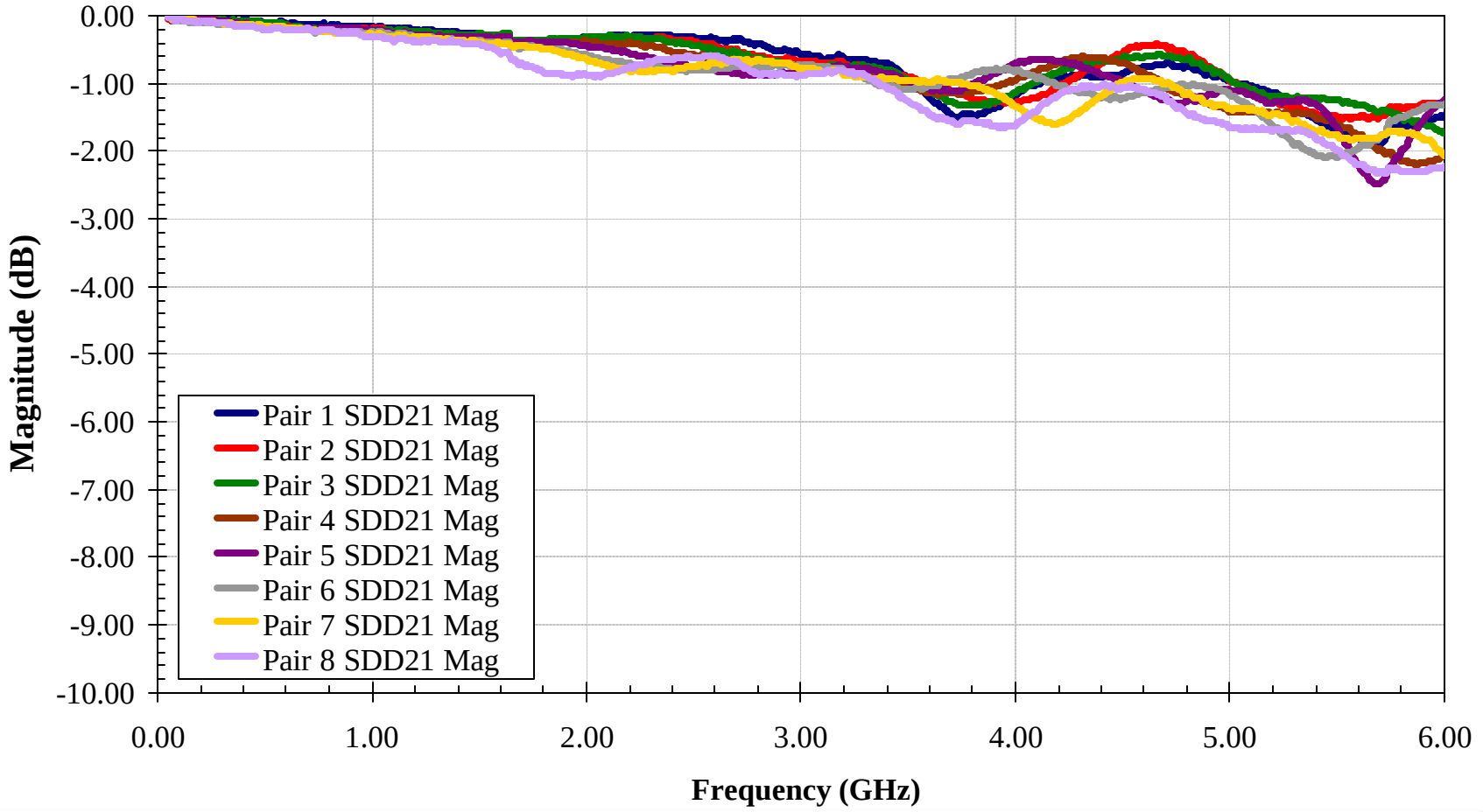
Synchronous Noise
Multiple aggressors

Pair 7	1.6%	Pair 8	2.7%
Pair 5	2.1%	Pair 6	2.4%
Pair 3	2.6%	Pair 4	2.2%
Pair 1	3.0%	Pair 2	1.0%



Edge rate: 47 ps (20-80%)

MultiGig RT-2 Differential - Throughput



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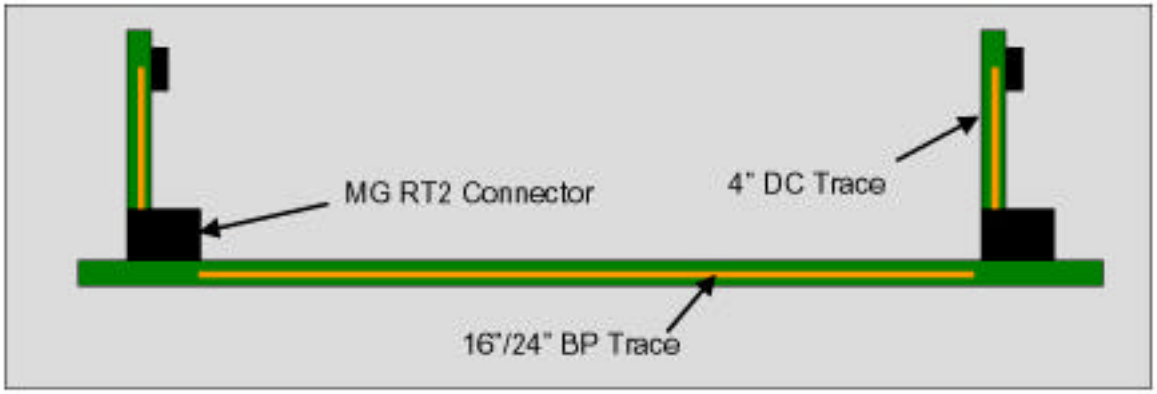
Physical Test Environment

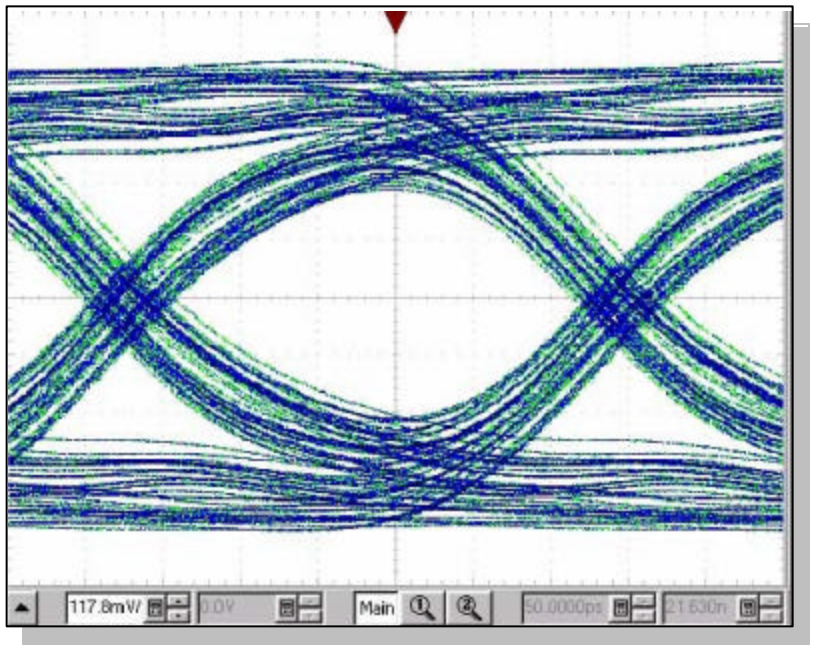


- Two RT2 connectors, a backplane and 2 daughtercards
- Backplane thickness designed at 0.200” with common FR4 material
- Daughtercard thicknesses designed at 0.125” with common FR4 material
- Trace widths designed at 6 mils on backplane and daughtercards
- 100 differential pairs on all boards
- All connector rows analyzed during the testing
- Top and bottom layer via connections included
- Top layer via connections designed with and without counterboring

Measured RT2 Eye Pattern (Worst-case trace-to-via connection)

Test Conditions:

- 16” FR4 backplane traces
- 4” FR4 daughtercard traces
- Top layer via connection
- No counterboring
- 2 7 -1 PRBS
- 46.8% Eye Opening



Measured RT2 Eye Pattern – 16” Backplane, Top Layer, No Counterbore

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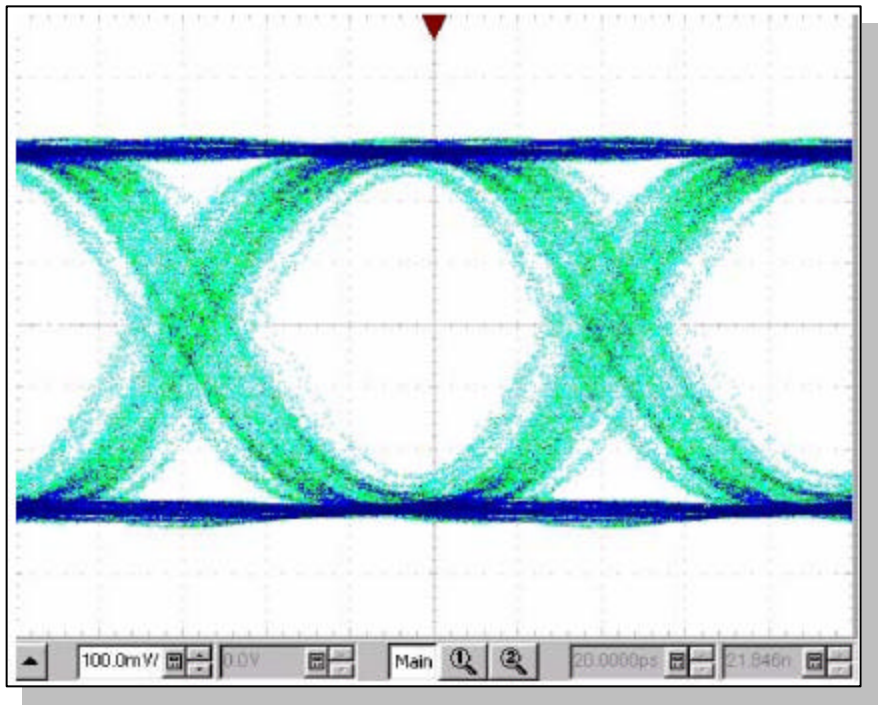
10 Gbps Data with Advanced Silicon



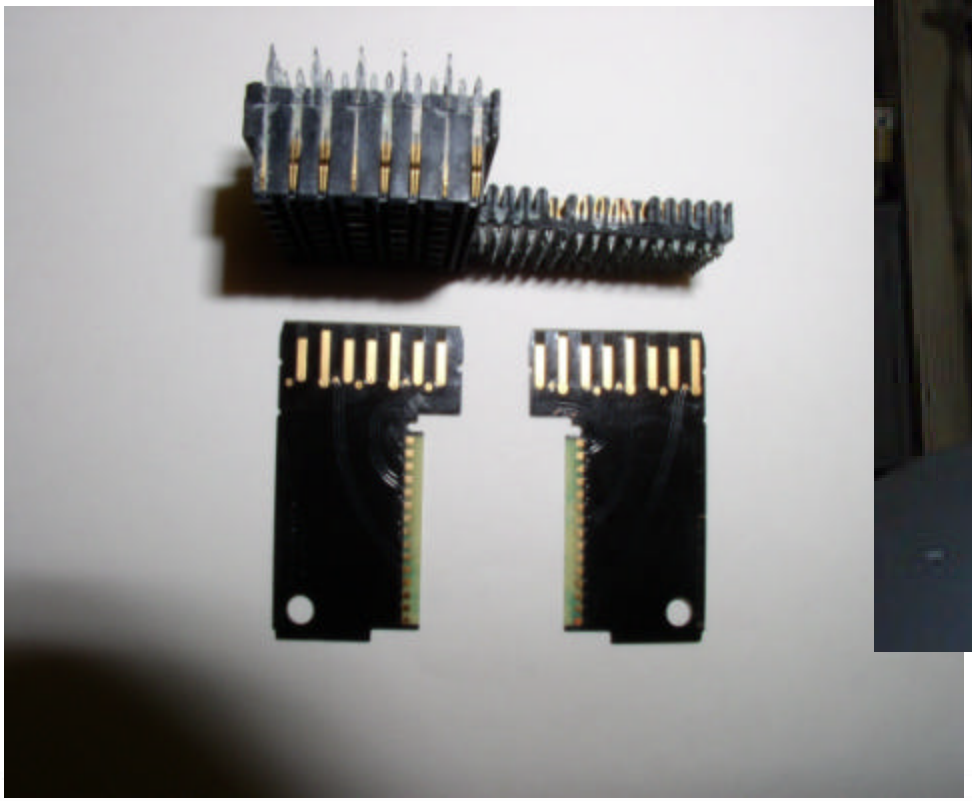
- Successful recovery of signal
- Not possible at 10 Gbps without advanced silicon
- Test Conditions
  - 24” FR4 backplane traces
  - 4” FR4 daughtercard traces
  - 6-mil trace widths
  - Top layer via connection
  - Counterbored vias
  - 2 7 -1 PRBS
  - Advanced Silicon
  - Successful data recovery
- Advanced materials will further improve results.

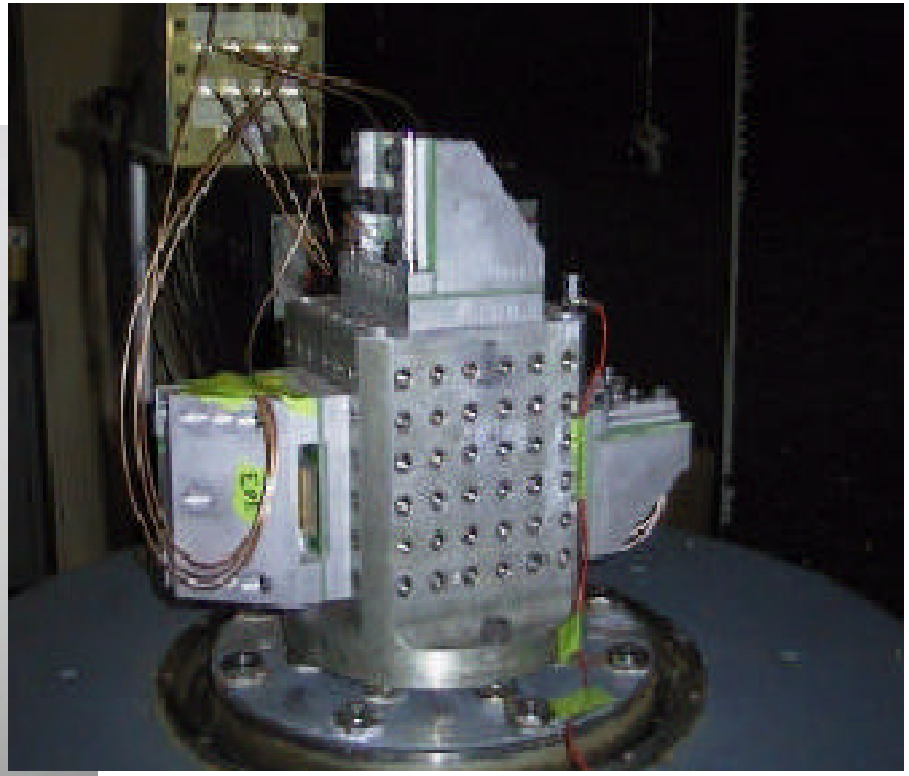
Environmental Testing (MIL-COTS-Telco)

- Concerns raised about MIL-COTS-Teclo acceptance of edge card connectors
  - **Address gas tight seal concerns**
  - **Verifies acceptable operation under vibration**
- MIL environment
  - **Shock (50g's), Vibration (15g's), Humidity (condensing)**
  - **Salt fog**
- Recognized Standards
  - **MIL-STD-1344A (MIL-COTS)**
  - **IEC 603.2 (General)**
  - **Telcordia GR-1217 (Telco)**

Test	Group A: Static Test at Component Level	Group B; Dynamic Test at Component Level
Initial Examination of Product	1	1
Vibration – Sine (+ monitor for discontinuity)		5
Vibration – Random (+ monitor for discontinuity)		6
Vibration – Shock (+ monitor for discontinuity)	5	7
Thermal Shock	7	
Salt Fog	11	
Low-Signal Level Contact Resistance (LLCR)	2, 6, 8, 12	2, 8
Insulation Resistance	3, 14	3, 9
Dielectric Withstanding Voltage	4, 15	4, 10
Visual examination w/ microscope at 8X magnification.	9, 13	11
Mate/unmate 25 cycles	10	

Test Setup & Test Sample





Pass/Fail Criteria

- Discontinuity
  - **Test Method EIA-367-87 Nanosecond-Event Detection for electrical Connectors.**
  - **Contacts were continuously monitored for discontinues of 10 Ohms or greater during Shock and vibration testing.**
  - **No Discontinuities were noted.**
- Low-Signal Level Contact Resistance (LLCR)
  - **20 mV open circuit, 100 mA short circuit**
- Insulation Resistance
  - **500 Volts DC applied for 2 minutes to mated connector**
  - **100 MegOhm minimum allowed**

Test Conclusions

- Passed MIL-STD-1344A tests for
  - **Humidity, Condensing**
  - **Salt Fog**
  - **Thermal Shock, -55 to +125 C**
  - **Vibration, random 11.95 GRMS**
  - **Vibration, simple harmonic motion, 15 gravity units**
  - **Shock, half-sine, 11 milliseconds, 50g's**
- Passed Telcordia GR1217
  - **Quality level III (highest)**